PARAGRAPH [0020] SHOWING AMENDMENT OF FEBRUARY, 2005

[0020] As used herein, a "shell-and-tube heat exchanger" is a heat exchanger comprising a plurality of tubes aligned generally parallel to each other and whose outer surfaces are spaced ~~spaces~~ apart from each other, a pair of plates (often termed "tube sheets") through which the tubes pass and to which the outer surfaces of the tubes are sealed at or near each end of the tubes, and a shell surrounding all of the tubes and sealed to the outer edges of the tube sheets thereby defining an enclosed space which contains all of the tubes. The shell also extends past the tube sheet at both ends of the heat exchanger and each end normally terminates in a flange connection. The volume between the flange connection and the tube sheet is termed a "heat exchanger bonnet".

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[0020] As used herein, a "shell-and-tube heat exchanger" is a heat exchanger comprising a plurality of tubes aligned generally parallel to each other and whose outer surfaces are spaced apart from each other, a pair of plates (often termed "tube sheets") through which the tubes pass and to which the outer surfaces of the tubes are sealed at or near each end of the tubes; and a shell surrounding all of the tubes and sealed to the outer edges of the tube sheets thereby defining an enclosed space which contains all of the tubes. The shell also extends past the tube sheet at both ends of the heat exchanger and each end normally terminates in a flange connection. The volume between the flange connection and the tube sheet is termed a "heat exchanger bonnet".

PARAGRAPH [0040] SHOWING AMENDMENT OF FEBRUARY, 2005

[0040] **Helium purification**. A catalytic oxidation system for helium purification is shown in Figure 5. Helium is taken from a pipeline at a pressure of 400-600 psig. It can contain as much as 4-5% hydrogen and 3% methane at this point. The helium is preheated slightly in a heater (not shown) to approximately 150 °F. This high pressure helium stream is stream 40. Oxygen is added to stream 40 via stream 39. The amount of oxygen that is added is chosen so that reaction of all the oxygen with hydrogen will not generate heat that raises the temperature of the gas stream above approximately 750 °F; at this temperature undesirable combustion of methane in the stream may begin. Composition of the helium stream at various locations in the process is shown in Table 3. The mixture of helium, hydrogen, methane, and oxygen passes into catalyst spool piece 42 and flows through monolith catalyst 43. A detailed view of the spool piece is not shown, but it would look identical to the drawing for CO_2 purification shown in Figure 3. A gas distributor 41 may be positioned near the entrance of the spool piece to ensure that the gas is distributed equally to all the catalyst passages. This optional distributor may consist of a perforated plate or some other dispersion device. The catalyst consists of a platinum group metal deposited on a monolith substrate. The monolith is in the form of a ceramic honeycomb, a ceramic foam, or a metal foil. The oxygen and hydrogen

in the helium react over the catalyst. The helium stream is heated by this reaction. The hot partially purified helium stream 44 exits catalyst spool piece 42 and enters the tube side of shell and tube heat exchanger 45. Spool piece 42 and heat exchanger 45 are directly attached to each other by a flange connection. The helium stream is cooled by heat exchange with water or another cooling fluid that flows counter-currently through the shell side of the heat exchanger. The cooled partially purified helium stream 46 leaves the heat exchanger at a temperature of 100-200 °F and enters catalyst spool piece 47. A detailed view of spool piece 47 is not shown, but it would look identical to the drawing for point-of-use CO_2 purification shown in Figure 8. Spool piece 47 and heat exchanger 45 are directly attached to each other by a flange connection. Additional oxygen in stream 55 is added to the helium stream via inlet port 56. The inlet port is designed to distribute the oxygen throughout the cross-section of the spool piece. A cross-shaped injector with a graduated series of holes extending from the center of the spool piece on each arm and designed for a constant pressure drop across each hole is one example of an appropriate inlet port. This injector would inject oxygen against the flow direction of the helium stream. Other injector designs can be implemented as long as they disperse the oxygen sufficiently. Enough oxygen is added to react with the remainder of the hydrogen in the helium stream. The gas stream passes through a gas distributor 49 to ensure that the gas is distributed equally to all the catalyst passages. This distributor may consist of a

perforated plate or some other dispersion device. The helium stream then flows through a monolith catalyst 48, where the remainder of the hydrogen and oxygen react. The catalyst consists of a platinum group metal deposited on a monolith substrate. The monolith is in the form of a ceramic honeycomb, a ceramic foam, or a metal foil. The hydrogen content of the helium is reduced to a few ppb. The helium leaves spool piece 47 as stream 50, and it is processed further in the helium production plant. Cooling water or another cooling fluid enters heat exchanger 45 as stream 52. It is heated as it removes heat from the hot helium ~~argon~~ stream, and it exits the heat exchanger as stream 53. Helium stream 50 must be cooled before it can be processed further in the helium plant.

PARAGRAPH [0040] AS AMENDED FEBRUARY, 2005

[0040] **Helium purification.** A catalytic oxidation system for helium purification is shown in Figure 5. Helium is taken from a pipeline at a pressure of 400-600 psig. It can contain as much as 4-5% hydrogen and 3% methane at this point. The helium is preheated slightly in a heater (not shown) to approximately 150 °F. This high pressure helium stream is stream 40. Oxygen is added to stream 40 via stream 39. The amount of oxygen that is added is chosen so that reaction of all the oxygen with hydrogen will not generate heat that raises the temperature of the gas stream above approximately 750 °F; at this temperature undesirable combustion of methane in the stream may begin. Composition of the helium stream at various locations in the process is shown in Table 3. The mixture of helium, hydrogen, methane, and oxygen passes into catalyst spool piece 42 and flows through monolith catalyst 43. A detailed view of the spool piece is not shown, but it would look identical to the drawing for CO_2 purification shown in Figure 3. A gas distributor 41 may be positioned near the entrance of the spool piece to ensure that the gas is distributed equally to all the catalyst passages. This optional distributor may consist of a perforated plate or some other dispersion device. The catalyst consists of a platinum group metal deposited on a monolith substrate. The monolith is in the form of a ceramic honeycomb, a ceramic foam, or a metal foil. The oxygen and hydrogen in the helium react over the catalyst. The helium

stream is heated by this reaction. The hot partially purified helium stream 44 exits catalyst spool piece 42 and enters the tube side of shell and tube heat exchanger 45. Spool piece 42 and heat exchanger 45 are directly attached to each other by a flange connection. The helium stream is cooled by heat exchange with water or another cooling fluid that flows counter-currently through the shell side of the heat exchanger. The cooled partially purified helium stream 46 leaves the heat exchanger at a temperature of 100-200 °F and enters catalyst spool piece 47. A detailed view of spool piece 47 is not shown, but it would look identical to the drawing for point-of-use CO_2 purification shown in Figure 8. Spool piece 47 and heat exchanger 45 are directly attached to each other by a flange connection. Additional oxygen in stream 55 is added to the helium stream via inlet port 56. The inlet port is designed to distribute the oxygen throughout the cross-section of the spool piece. A cross-shaped injector with a graduated series of holes extending from the center of the spool piece on each arm and designed for a constant pressure drop across each hole is one example of an appropriate inlet port. This injector would inject oxygen against the flow direction of the helium stream. Other injector designs can be implemented as long as they disperse the oxygen sufficiently. Enough oxygen is added to react with the remainder of the hydrogen in the helium stream. The gas stream passes through a gas distributor 49 to ensure that the gas is distributed equally to all the catalyst passages. This distributor may consist of a perforated plate or some other dispersion device. The

helium stream then flows through a monolith catalyst 48, where the remainder of the hydrogen and oxygen react. The catalyst consists of a platinum group metal deposited on a monolith substrate. The monolith is in the form of a ceramic honeycomb, a ceramic foam, or a metal foil. The hydrogen content of the helium is reduced to a few ppb. The helium leaves spool piece 47 as stream 50, and it is processed further in the helium production plant. Cooling water or another cooling fluid enters heat exchanger 45 as stream 52. It is heated as it removes heat from the hot helium stream, and it exits the heat exchanger as stream 53. Helium stream 50 must be cooled before it can be processed further in the helium plant.